

Biochar Market Analysis for San Juan County and the Pacific Northwest

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EXECUTIVE SUMMARY

Introduction

Charcoal, referred to as ‘biochar’ when applied in agricultural soils, has been shown to store and stabilize carbon, retain nutrients and water, increase biological activity, and increase a plant’s ability to absorb nutrients. New research on biochar’s influence on carbon stabilization and increased biological activity in soils presents an opportunity for charcoal to become a foundational element of *regenerative agriculture*. Utilization of biochar could be an important strategy for rebuilding fertility in degraded crop lands, and helping farmers and gardeners develop resilient crops in a changing climate. Further, biochar holds the potential to integrate sustainable agriculture with sustainable forestry, helping turn the excess biomass of overstocked forests into a long-term asset for food security. The purpose of this analysis was to examine the state of the biochar industry in San Juan County and the greater Pacific Northwest in order to understand if biochar is a growing market, and what potential exists for expansion.

Methodology

This market analysis conducted interviews with 20 gardeners, 9 farmers, 4 retail stores, 3 biochar businesses, 2 food sales and marketing executives, 1 forestry company, and the former San Juan County Drinking Water Supervisor. Interviews were designed to understand customer interest, knowledge level, and interest in purchasing biochar. The study also looked at the sales, production, and marketing of biochar, and potential markets for sales in San Juan County and in the Pacific Northwest. This paper examines economic elements of biochar additions into farm soils using soil research from the University of Montana that was conducted on farms in San Juan County. The study then explores current markets for biochar in San Juan County, the Pacific Northwest, and internationally to gain insight into existing sales and the potential for expansion.

Key Findings

- The study found a very small active biochar market in San Juan County, with nearly \$3,000 in documented sales in 2018.
- Interviews established that the garden market could likely be expanded by adding additional retail locations and providing more educational outreach to customers through retail businesses.

- Retail locations identified biochar's high price point, as well as the difficulty in substantiating its beneficial claims relative to other garden or farm soil amendment products, as prohibitive to sales. Without customer knowledge of evidence for these benefits, a high price point limits the number of customers willing to take a risk in purchasing the product.
- Farmers would like to produce biochar themselves, and some are open to buying it at low costs. The study also found that farmers do have a significant level of interest in the soil health categories biochar can address. With low margins and a variety of other costs, current market prices are still a deterrent for commercial farmers and gardeners.
- None of the gardeners, farmers, and only one biochar business, knew about biochar's 'negative priming' effect, or its ability to stabilize the native carbon in soil. This lack of knowledge is notable, as carbon stabilization was the highest rated benefit of interest in farmer interviews, the only soil health topic to receive a perfect score in interest level.
- There are challenges in biochar's marketability because biochar made at different temperatures and feedstocks will have different influences in the soil.
- Biochar will struggle to access larger scale farms in the Skagit Valley because more than two-thirds of the farmed land is cultivated on one-year leases where the farmer does not have long-term investment in the soil.

Biochar faces a marketing problem in that most garden customers do not understand why biochar's most significant long-term impact on the soil—storing and stabilizing carbon—is important. Further education would need to be offered to potential customers to increase their understanding of carbon's role in soil health. Biochar has the potential to integrate with initiatives like the Rodale Institute's Regenerative Organic Certification and other carbon-based marketing campaigns to increase consumer interest in the food grown. If demand can increase for food grown in biochar-amended soils, the number of farmers and gardeners interested in using biochar will also likely increase.



PRODUCT DESCRIPTION: BIOCHAR BENEFITS & POTENTIAL

Biochar and Soil Carbon

A third of the carbon in our atmosphere since the industrial revolution comes from plowing the world's fields.¹ When oxygen interacts with carbon in the soil, it produces carbon dioxide that rises into the atmosphere. A gas that traps heat from the sun within the earth's atmosphere, carbon dioxide makes up more than three-quarters of the greenhouse gas emissions in the world.² Carbon off-gassing from fields has also produced a carbon crisis in agriculture, with 50-70% of the world's carbon in farmland soils off-gassed into the atmosphere due to tillage.³

Carbon, known as the building block of life, serves as the fuel source for microbial activity in soil which digests nutrients for plants in a similar fashion to human intestinal flora with food. This microbial system also serves to distribute these nutrients into the cell tissue of plant roots. A healthy biological soil system creates the most resilient soil condition for crops to withstand climatic stress. Our global farmlands are experiencing historic lows in fertility while crops will face increased unpredictability in weather patterns. The Intergovernmental Panel on Climate Change estimates that global food production could be reduced by up to 17% by the year 2100 due to crop failures from increased weather variation.⁴ The population in the year 2100 is estimated to be 11.2 billion people.⁵



Photo: K.salo.85 via Wikimedia Commons

¹ David Montgomery, *Growing a Revolution: Bringing Our Soils Back to Life*. New York: 2017, Pg 54

² <https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data>

³ http://e360.yale.edu/features/soil_as_carbon_storehouse_new_weapon_in_climate_fight

⁴ https://www.ipcc.ch/pdf/assessment-report/ar5/wg2/drafts/fd/WGIIAR5-Chap7_FGDall.pdf

⁵ <http://www.un.org/sustainabledevelopment/blog/2017/06/world-population-projected-to-reach-9-8-billion-in-2050-and-11-2-billion-in-2100-says-un/>

Biochar, or charcoal, is a stable form of carbon that sequesters part of the carbon in the organic material being burned. Every pound of charcoal sequesters 2.93 pounds of carbon dioxide from the atmosphere.⁶ Carbon in the charcoal forms differently at different temperatures. Research illustrates that higher production temperatures lead to increases in charcoal surface area, carbon stabilization rate, and moisture retention while decreasing in Cation Exchange Capacity, which equates to biochar's ability to retain nutrients. Lower temperature biochars, below 750° F, have lower carbon stabilization and moisture retention, but higher nutrient retention capabilities and immediate positive biological impact with more immediately bioavailable carbon.⁷

The carbon stabilization rate of the higher temperature biochars is likely the most significant benefit biochar provides, yet this market research paper found that it was unknown to gardeners, farmers, and biochar businesses.

Research on carbon stabilization with biochar, termed “negative priming” has become a significant topic of study since 2014. Papers have found up to a 68.8% carbon stabilization rate, but on average a 40% increase across 395 academic papers.^{8,9} Other research indicates that biochar with higher pH (8.1-9) holds increased soil carbon stabilization capacities and more enhanced biological activity in comparison to biochar with lower pH values.¹⁰ Deciduous trees, because of their naturally higher pH, will on average produce biochar with higher immediate value for the soil. This finding means that biochar, specifically with higher pH feedstocks, could serve as a foundation for other regenerative agricultural practices such as cover cropping, green mulching, no-till, and animal rotations. If this stabilization influence of biochar was more commonly understood, it could influence biochar's marketability as regenerative agriculture becomes an increasingly familiar concept for food producers and consumers.

⁶ <https://fortress.wa.gov/ecy/publications/documents/0907062.pdf>

⁷ *Influence of biochar produced from different pyrolysis temperature on nutrient retention and leaching*, Hongguang Cheng et al, 2017

⁸ Biochar suppressed the decomposition of organic carbon in a cultivated sandy loam soil: A negative priming effect, Weiwei Lu et al 2014

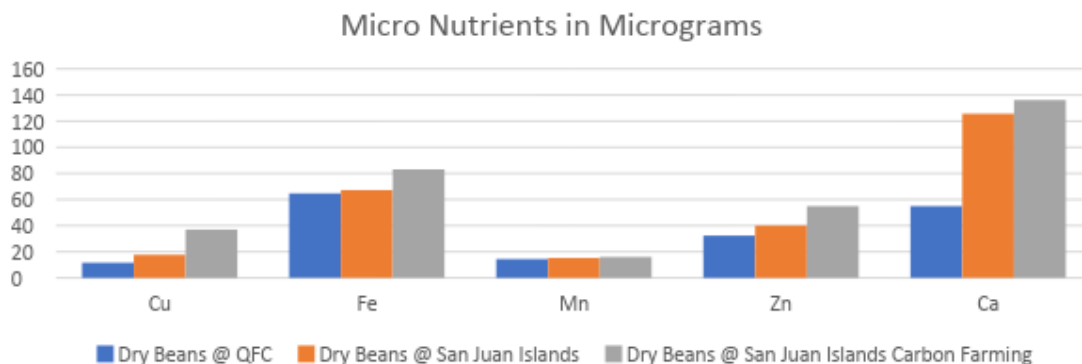
⁹ Response of soil carbon dioxide fluxes, soil organic carbon and microbial biomass carbon to biochar amendment: a meta-analysis Shuwei Liu et al, 2016

¹⁰ Response of soil carbon dioxide fluxes, soil organic carbon and microbial biomass carbon to biochar amendment: a meta-analysis Shuwei Liu et al, 2016

Research in San Juan County^{11, 12}

In 2015, University of Washington conducted research on ten farms growing beans and found that:

- Biochar increased soil carbon levels between 32-33%.
- Biochar enhanced nutrient retention in the soil: nitrate nitrogen + 45-54%, organic N + 48-110%, inorganic phosphorous + 29%.
- Biochar increased nutrient density of plants: plants had an increase in Potassium, Iron, Magnesium, and Zinc. The study compared the average nutrient content of the dry beans grown on the ten San Juan County farms, both in their non-biochar plots represented in orange in the image below, and their biochar plots (termed Carbon Farming) represented in grey. These were then compared to dry beans from a Seattle QFC grocery store, represented in blue.



In a separate study in 2016, researchers established charcoal plots on six farm sites in San Juan County, which all grew Kuri winter squash.

- Soil carbon increased in the biochar plots by 31-33%.
- Moisture retention increased 10-25%.
- Biological enzymes were increased by 24-28%.
- Nitrogen and phosphorous retention levels were significantly increased.

Key trends in this research also showed that there was evidence of decreased nutrient leaching and microbial biomass increase through the addition of biochar.

¹¹ Published in the scientific review journal Agriculture, Ecosystems, & Environment, 2017.

¹² UW PhD candidate Si Gao and the Director of the University of Washington School of Environmental and Forestry Sciences, Dr. Tom DeLuca.

Meta Research on Crop Productivity

Another meta-analysis paper examined 238 studies of biochar's influence on plant productivity. They found that vegetable productivity increased by an average of 28.6%, and that legume crops, such as peas, beans, and vetch, increased productivity by an average of 30.3%.¹³



Biochar Financial Analysis

In coordination with the PhD candidate Si Gao at the University of Montana, this study worked to quantify specific elements of biochar costs of production and cost savings based on the San Juan field trials of 2016. There is a need to explore a series of additional topics related to potential cost savings to customers, such as financial savings from water use reduction, decreased crop loss, and cost savings on fertilizer purchases annually. More specifically, there is a need for increased understanding of the economic impact of biochar's influence in soil over extended periods of time. The potential for a one-time biochar soil amendment to provide cost savings through the customers' lifetime and beyond will provide the most robust financial

• ¹³ Biochar's effect on crop productivity and the dependence on experimental conditions—a meta-analysis of literature data, Xiaoyu Liu 2013

argument for purchasing. Continued on-farm research is needed to illustrate the long-term influence of biochar in agricultural soils.

The following parameters and values were used for the cost-benefit analysis:

Biochar feedstock and crop parameters

- Woody biomass used as feedstock is 60-80% carbon by volume.
- Crop grown: Winter squash (*Cucurbita maxima*).
- Soil pH: 6.5-7.0 across all test farms .
- Biochar application rate: 20 t ha⁻¹ on all test plots.
- Crop yield: 31.38% average increase in crop yield in biochar treated plots across all test farms.
- The price of the squash on farmers' market: \$1.50 per pound = \$3.31/kg.
- Cost of fertilizer: market price: \$35.00/40lbs Nutri-rich 8-2-4. In our field trial, we used 4kg (8.5lbs) = $35.00 / 40 \times 8.5 = \7.5 for test plots that were treated with fertilizer. Assume a test plot = 4m², there was a total of 150m² farmland that was applied with chicken manure (control and biochar plots did not have chicken manure applied).

Biochar production cost analysis for manual forest restoration or on-farm production:

- Feedstock collection: In our study, it took 8.5 hours of human handling to aggregate feedstock and load the kilns manually. However, there are two models that could make this process more efficient:
 1. Forest restoration (high-end): This will use heavy machinery, specifically an excavator, which decreases the time of loading significantly.
 2. On-farm production (low-end): The farmer does not get paid to collect feedstock, but uses biochar production to clean up debris they would otherwise burn to ash.
- Post processing including crushing, adding fertilizer, windrowing material to distribute nutrients is at 2.5 hours.
- Fertilizer (8-2-4 Nutri-rich fertilizer) for charging 1.5 yards of biochar: 70 lbs. Cost for this study's model is \$61.25.
- Production technology (Flame Cap Kiln burn: a total cost of \$200.00 for the stainless-steel burning tool, reused indefinitely).
- Distribution: in small-scale farming, hand distribution and application is used.
- Overall biochar production and application hard costs before transport: \$261.25.

CO₂ sequestration valuation:

- The biochar used in our study has a 68% carbon content: every ton of biochar applied to soil contains 0.68 ton of carbon = 2.50 tons of CO₂ sequestered.
- In our field trial, we used 300kg of biochar = 0.33 tons of biochar = 0.2244 tons of carbon = 0.823 tons of CO₂ sequestered.
- CO₂ is \$200.00 per ton; our field trial sequestered $0.823 \times \$200 = \164.6 CO₂ (per 150m²).

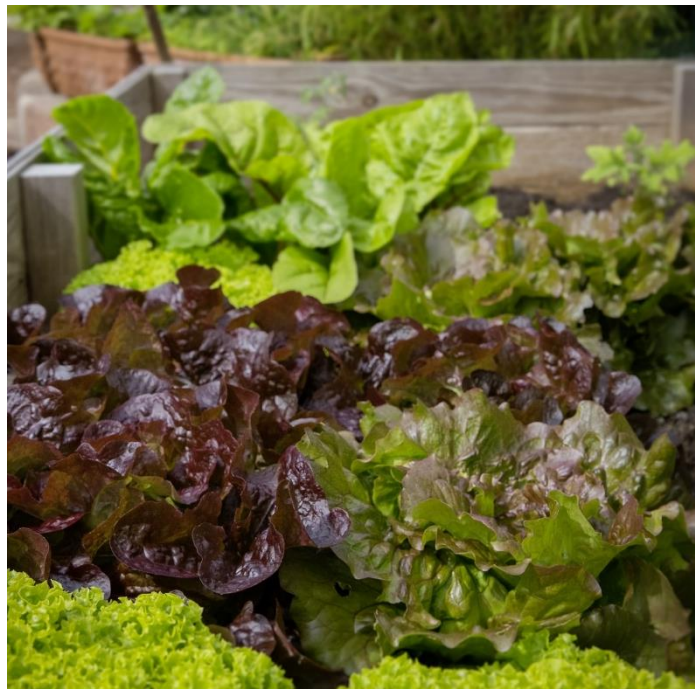
Crop yield revenues (winter squash):

- Our squash total yield in char-treated plots was 52kg higher than non-biochar treated plots. $\$3.31/\text{kg} \times 52\text{kg} = \172.00 .

Analysis of Findings

The cost-benefit analysis for our small-scale study only looked at crop yield increase and carbon credits as methods for biochar to improve profitability. Based on our simple study, a kiln 5 feet tall and 5 feet in diameter would provide enough biochar to produce additional value of \$301.25. That total is created through the \$172 increase in crop productivity and the \$164.6 in carbon credits. Hard costs were \$261.25, but the cost of the stainless-steel kiln is a one-time expense and can be utilized indefinitely. These numbers look at benefits over a one-year period

and biochar has illustrated the ability to influence soil health for the duration of its resonance time in soil, between several hundred to 10,000 years. Illustration of this long-term benefit through research would transition these financial numbers into potentially significantly positive earnings.



SAN JUAN COUNTY MARKET ANALYSIS

Surveys were conducted with 20 gardeners and 7 farmers in San Juan County to understand their interest in biochar and their potential to buy or make the product.

Gardener Market Survey

Gardener interviews were conducted at the Orcas Coop with a sample tasting of salad greens grown with biochar from Forage Farmstead.

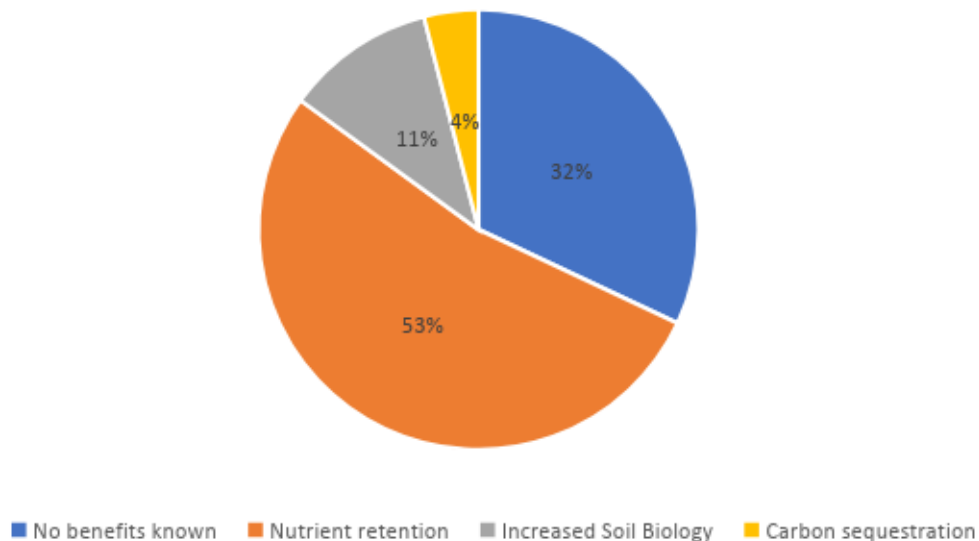
Familiarity with Biochar

Interviewees were initially asked to evaluate their understanding of biochar on a scale of 1-5, with 5 being a significant knowledge about the product. The average score among the 20 gardeners was 2.3 out of 5, illustrating the average gardener was mostly unfamiliar with the product. Several gardeners scored themselves a 5, which raised the average score significantly. 7 out of 20 gardeners had never heard of biochar.

Benefit Analysis

Gardeners were then asked to name the top benefit biochar provides. The results are shown in the chart below. It is important to note that carbon sequestration was the smallest benefit named, and that no one knew about the carbon stabilization benefit of biochar.

Gardener Knowledge of Biochar



Chance of Purchasing Biochar

Interviewees were asked to score their level of interest in buying biochar from 1-5, with 5 as significant interest. The average gardener gave a response of 2.4.



Photo: [Thomask0](#) via Wikimedia Commons

Chance of Purchasing After Description of Benefits

A brief background to biochar was provided, as well as a summary of the local research in farm soils and a sample of salad greens grown with biochar. Gardeners were asked to once again score their level of interest in purchasing biochar from 1-5. The average score rose to 3.4. The survey found that while some knowledge about biochar does exist in the gardening community on Orcas, the average interviewee knew very little about a product that had been for sale at the coop for the past 5 months, and for which marketing materials touting the benefits of the product had been made available. Therefore, customers were not engaging with the biochar marketing materials in an effective way and/or the marketing materials were not presented in a manner that were sufficiently persuasive to drive sales.

In addition, the major benefit interviewees attributed to biochar—nutrient retention (receiving 53% of answers)—is likely a less significant long-term impact of biochar in soil, as cited in the beginning of this study. The influence of biochar on carbon levels and biological activity only accounted for 15% of total answers, and 2 of these gardeners were not familiar with the role of carbon in increasing soil biology.

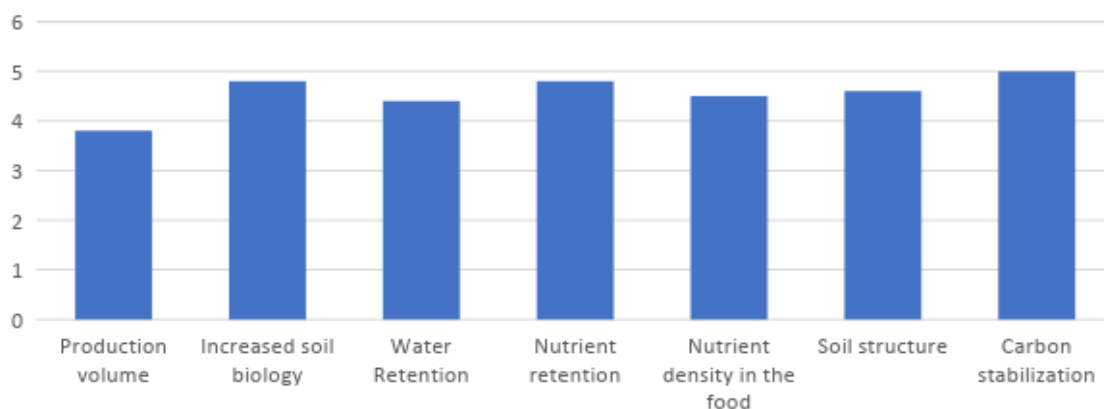
A key finding from the gardener interviews was the increase in interest in purchasing biochar after a description and food sample were given. 6 of the 20 gardeners interviewed decided they would or did purchase biochar after the interview, which resulted in the point increase from question 3 to question 4. As biochar exists as a unique amendment in the traditional soil amendment categories, biochar sales may require an in-person marketing campaign in retail locations, either training the sales staff or providing workshops, or sampling through the store. Coops are unique retail locations that allow for both the sale of biochar as well as food sampling. In this study, the sample provided a natural transition to speaking about the increased nutrient density of the crops, and consumers appeared to respond positively to the food sample, often expressing the desire to grow nutrient-dense crops in their gardens.

Farmer Biochar Survey

9 farmers were interviewed and surveyed about their interests in biochar. Farmers were asked four questions:

Question 1: Please rank the following on a scale of 1-5 in importance, with 5 as something you see as very important to your farm and 1 as not important.

The first question sought to understand which topics relating to biochar were of greatest importance to farmers. The following chart reflects the average scores among the 9 farmers:



It is important to note that carbon stabilization was the only category to receive a perfect score. Increased soil biology and nutrient retention, both byproducts of increased soil carbon levels, were tied for the second most highly-rated categories with scores of 4.8.

Question 2: How likely you to make biochar for your farm on a scale of 1-5. What are the barriers to producing it yourself?

The average score was 4.4, illustrating that most of the farms interviewed either do or are significantly interested in producing biochar for their farm. Key limitations cited were access to metal cylinders for kilns, machinery for accessing debris within the forest, the knowledge and skills for biochar production, and resource barriers with finances and time allocated to other areas of the farm.



Question 3: If you knew biochar would provide increased enhancements in the categories named in question 1 for at least 30 years, what would that be worth to you? If it was 55 yards of biochar per acre for a *one-time application*, what would you pay per yard and how many yards do you think you'd buy?

6 of the 9 farms said they would be interested in producing biochar themselves and would not buy it, and even the 3 farmers who expressed potential interest in purchasing biochar said they would prefer to make it themselves.

The prices put forward ranged from \$18 per yard to \$150 per cubic yard, with the farmer expressing a willingness to pay \$150 per yard stating they would prefer to make it themselves. Farmers who did express interest in purchasing biochar were on the low end of the pricing spectrum. One farmer that does not own her own land said she would purchase biochar for leased land if she anticipated growing there for 3-5 years. She cited \$2,000 for a one-time application. Another long-term farmer in the County cited that she would spend \$1,000 per acre. When calculated out at 55 yards per acre, which is the recommended base application, that is \$36 per yard, and \$18 per yard respectively. The prices these farmers were willing to pay range from ½ to ¼ the price of biochar produced on a large scale by Oregon Biochar Solutions and Pacific Biochar, not including the cost of distribution.

Steve Bensel, who has run Nootka Rose Farm with his wife Linnea Bensel for more than 40 years and has been producing and applying biochar now for 10 years, put forth his thoughts on calculating the value of biochar over time.

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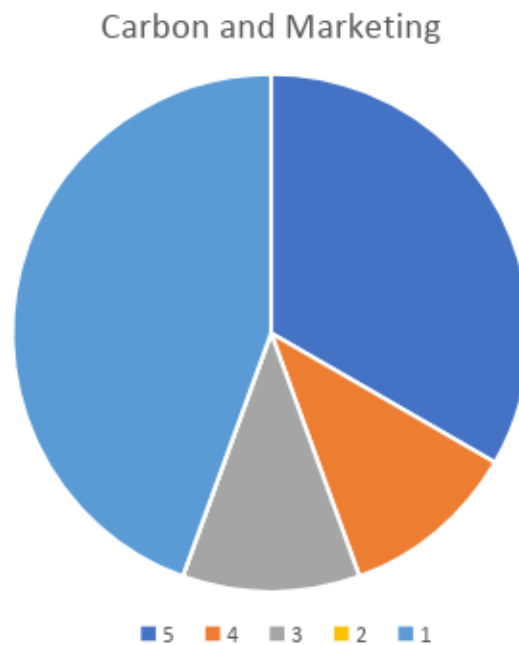
If I add up the cost of my major inputs, 8-2-4, lime, water, I come up with something in the neighborhood of \$10/bed/year, or \$820/acre. If the addition of char would reduce the need for these inputs by 30%, I would be saving \$250/acre/year. Over 30 years, that is a lot of money - \$7500). So, by this line of thinking, the value of the char is \$135/yard. Not many farmers are going to pay that. I'm not sure where to go from here—people don't want to just break even on a big expenditure, they want to make something on it. Even at half that cost, \$65/yard, it is still a lot of money for anything but the highest value crops. But I think most vegetable growers in this county would profit from spending the money. I make my own char and it is a lot of work, but I will continue to do it. It makes a huge difference in my garden.

This quote illustrates that with already small margins, vegetable growers struggle to justify the significant upfront investment to amend an acre. Bensel's math also illustrates that it requires accurate knowledge about biochar's long-term impact on the soil to ensure a return on the investment. Further long-term field trials must be conducted to give farmers predictions for the impact in their soil over time.



Question 4: On a scale of 1-5 (5 representing “significant help”), how much does storing carbon help in marketing your food products?

The fourth question focused on the marketing potential for biochar to increase sales if farmers could make it a part of their marketing or story to customers. The question averaged a 2.9 among farmers, indicating two almost equal ends of the spectrum. 4 farmers expressed significant interest in including carbon practices into their marketing materials, while the rest didn’t think it would influence their markets. One of these comments, from Nootka Rose Farm, captures the potential to express the importance of soil carbon, while also the lack of a current audience:



“ At this point no one cares directly. Our customers are interested in appearance, flavor, and shelf-life; all things that are enhanced by high soil-carbon levels but they are not making that connection yet. More education is needed.

This comment highlights the disparity between carbon’s important role in food quality and consumers lack of awareness of the benefits of soil carbon. The comment also points to an opportunity for the non-profit sector to assist both farmers with educating their customers and the general public about the importance of increased soil carbon.

Current Agronomy of Western Washington Organic Agriculture: Interview with Charlie Anderson, Organic Agronomist at Skagit Farmers Supply

In order to understand the potential impact of biochar on larger organic farms, an interview was conducted with Skagit Farmers Supply, the largest fertilizer cooperative in the Skagit Valley. Charlie Anderson works as the non-profit's organic agronomist, helping farmers design tailored fertilizer applications for their planting needs.

The average farm Charlie works with has 1-2% organic matter levels, and a Cation Exchange Capacity of 6-8, which mean that these soils retain almost no nutrients. Charlie said that because these high leaching soils accumulate almost no fertility from year to year, many of the farmers have taken a philosophy of *crop nutrient replacement* rather than *crop nutrient building*. These farmers aim to add the necessary amounts of macro and micro nutrients to replace the nutrients extracted in crop growth and harvest. "People used to think about feeding the soil to feed the plants. Now that's out the window. It's just feed the plants," Charlie said.

Another key factor to the low fertility investment farmers make in the Skagit Valley is that two-thirds of the farmed land in the valley is leased. Charlie said that leasing systems like this are standard across the country. He thought that farmers wouldn't likely buy a long-term fertility product like biochar for land they will likely only farm for that year or maybe the next.



Photo: Pattymooney via Wikimedia Commons

The amount farmers spend on fertilizer directly relates to their per acre net income, which can be as small as a hundred dollars an acre or more than \$10,000 per acre. Charlie classified this intensive type of agriculture as "truck farmers" because they usually distribute and market their own products in the back of their trucks to farmers markets and restaurants. Some of these small-scale, intensive producers can put up to 3,000 pounds of fertilizer per acre, which can cost up to

\$2,000/acre depending on the crops grown. Whereas "you won't find an earthworm anywhere" in conventionally cultivated soils, these small-scale producers are looking to increase general soil fertility. Charlie stated that most farmers won't care about soil carbon as it's not one of the

essential nutrients for annual crop production. But, according to Charlie, the “truck farmers” are often more interested in creating a soil ecosystem he said. He thought this would be the best demographic for potentially buying biochar.

Charlie has had six farmers come to him this year asking to buy biochar. He says there is increasing interest, but most farmers he knows consider it a product with anecdotal evidence and little university research to support its benefits. When asked if a summary of research would be helpful Charlie stated that he said farmers trust results in soils “like theirs.” He thought that test plots will need to be implemented in Skagit Valley soils to illustrate the effects on fertility. “The farmers I know need to see the benefits with their eyes.”



SAN JUAN COUNTY MARKET ANALYSIS

Market Summary

There were a total of around \$3,000 in documented biochar sales in San Juan County in 2018. The number is a partial estimate because some numbers were given as a ballpark summaries. Sales breakdown is:

- At the Orcas Coop Forage sold 16 cubic foot bags and 3 six cubic foot bags, for a total of \$497.84
- At the San Juan Coop Forage sold 3 cubic foot bags, and 1 six cubic foot bags, for a total of \$123.89
- Thornwood Farms sold a total of \$250 at the San Juan Island Farmers Market
- Forage sold 8 cubic foot bags to direct customers, and 1 six cubic foot bag, for a total amount of \$120.
- Natural Plant Solutions sold a total of 8 yards of biochar.

A series of interviews were conducted with retail businesses and biochar businesses on the topic of current sales and the potential for sales. Findings illustrated that biochar struggles to establish a market because it holds such a unique space among soil amendment products, both in the benefits provided as well as price point. Biochar will continue to struggle in developing a market without more educational outreach in coordination with sales.

Business Summary

Forage: Producer

As part of this market research, Forage conducted pilot sales of biochar at the Orcas and San Juan coops. The following is a breakdown of business income and expenses for the pilot sale:

- After the 40% retail deduction from the Orcas Coop, the total financial return was \$298.70.
- After the 30% retail margin from the San Juan Coop, the return was \$86.70
- Total profit from retail sales of \$385.42.
- In addition, Forage sold \$120 in direct customer sales, totaling 2.1 yards at \$505.40.

Costs included \$42.50 for printing and bags, and \$61.25 in fertilizer costs. Production, post processing, and bagging for the 2.1 yards of biochar totaled 16.5 hours. Bagging and

distribution required 4 hours, for a total of 20.5 hours of input time. After removing \$103.75 of hard costs from the \$505.40, it leaves a total of \$401.65 to cover time, which at 20.5 hours of investment results in an average of \$19.59/ hour.

Key findings from the sales pilot include:

- Both coops choose to have the display outside because of the product's size. The poly bags deteriorated in the sun, and the printed labeling needed to be laminated to withstand rain. In the future, thicker than 3-mil poly bags may be necessary to provide more durability in the elements, and printing on the bag is a strong consideration.
- A significant portion of sales resulted after in-store talks about biochar. A biochar display will potentially attract individuals already aware of the product, but likely will not entice a new customer who is not familiar with biochar.
- There is potential to sell different biochars with different fertilizer inoculants, such as including biological catalysts like humic acid or fermented liquid kelp. While this was not a part of the pilot sales project, in speaking with the coops this would potentially increase interest by generating increased options.



Photo: <http://thornbushlandscape.com/>

Thornbush Farms: Producer

Thornbush Farms is run by Roger Ellison, a permaculture nursery on San Juan Island. The nursery provides fruit, nut, and berry plants for food forests on San Juan Island. Roger defines food forests as landscapes “designed in the image of the savanna or open woodland ecosystem. Apples, plums and other fruits are planted in groupings that mimic natural systems, with berry bushes and herbs in the understory.” Thornbush has been selling biochar made on-site at the San Juan Farmer’s Market, totaling \$250 in 2018. Roger is interested in expanding into selling biochar at Ace and Browne’s. He identified a lack of display at the San Juan Farmers Market as a key problem for attracting customers. Because biochar is a unique product, increased marketing is important for sales. Roger cited the need for pre-made handouts that he could use in marketing biochar at the market. He believes, however, that the price will need to come down for the product to be

more affordable, and he’s not clear how to accomplish that with current small-scale production

methods. Roger does anticipate biochar becoming a standard soil fertility technique in the islands, but “maybe not as a commodity to sell.” Instead, he imagines that each farm might have their own kiln and production system that they use for processing wood waste.



Photo: <http://www.naturalplantsolutions.com/>

Natural Plant Solutions: Producer

Natural Plant Solutions offers compost tea, natural soil amendments including biochar, soil testing, and application services. Run by Andrew Borner, Natural Plant Solutions both produces biochar and sells biochar from Biochar Supreme. Sales over the last year totaled 8 yards of material, with 5 yards sold to a farmer for animal bedding. 1 yard was applied with the company’s no-till drill and seeder, which concentrates biochar directly in the seed bed. The last two yards were amended in compost that the business distributes to gardeners.

Biochar is a small fraction of Natural Plant Solution’s overall amendments, mostly due to its high price point. Andrew believes the price will need to come down by more than half in order to access the agricultural market. Andrew said that the biochar will need to be regularly tested by each producer so they can ensure quality and predict the influence of their biochar on a customer’s soils. In Andrew’s opinion the biochar industry is in its infancy and has not developed standards, testing procedures, or grading systems.

Rain Shadow Consulting Forestry: Producer

Rain Shadow Consulting provides consulting and management services to private and public landowners in northern Puget Sound, specializing in the protection and enhancement of rare ecological communities such as Garry Oak woodlands and native prairies. Carson Sprenger is a founder of the forestry company and works as a restoration forester and ecologist specializing in fire.

Carson sees biochar as a further step in storing carbon in our forests and improving the soil ecosystem.

Carson did his Masters thesis examining the regularity of fire in a Gary Oak ecosystem on Waldron Island in the San Juans. He understands the role that fire holds for thinning the forest understory and producing charcoal and ash for the soil. Carson sees biochar as a

way of mimicking the role of fire in a controlled way to maximize the production of charcoal.



Rain Shadow Consulting is interested in land owners, non-profits, or county lands to request biochar production of woody biomass for either agricultural use or to be spread in the forest. Healthy forests are carbon sinks, illustrated in the graphic below.

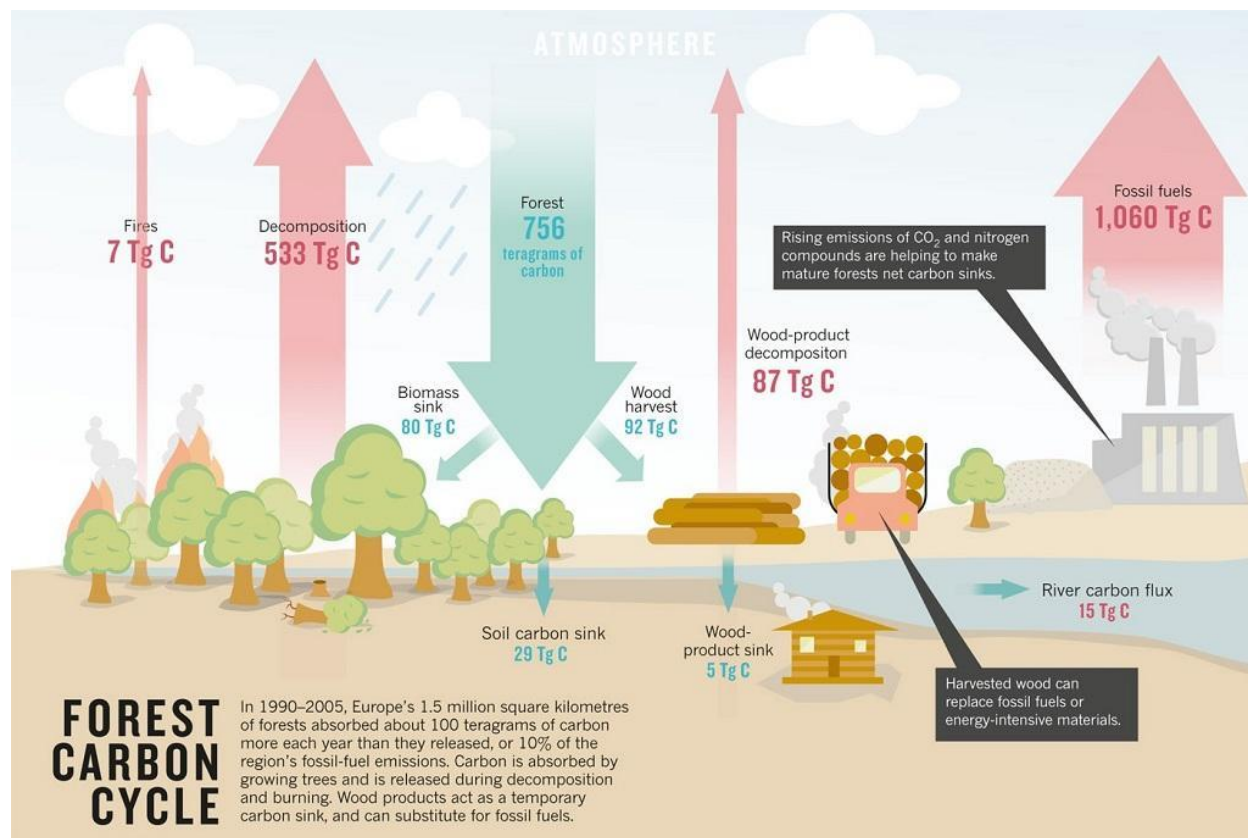


Photo: <https://www.americanforests.org/blog/forests-carbon-sinks/>

Orcas Coop: Retail Store

The Orcas Food Coop was the largest retail seller of biochar in San Juan County, with an outdoor display next to where people enter the store. The coop termed biochar “not a hugely popular item” but thought that interest would increase if it had been in the store starting at the



end of March rather than the beginning of May, when gardeners are doing more of their planning and bed prep. They strongly stressed the importance of demos, in-store food sampling, and classes on biochar as ways to market the product as, “It’s

Photo: www.visitsanjuans.com

something that many folks might not know about.” The head produce manager, Kristy Bredin, thinks that biochar has limited sales in the county, and once gardeners have amended their beds they will no longer be interested in continuing to purchase the product. The long-term nature of biochar, serving as an investment in soil health, is also what generates challenges in developing a stable business model and long-term, returning customers.



Photo: <http://www.islandhardware.com>

Island Hardware & Supply: Potential Retail Store

Island Supply, the local hardware and lumber store on Orcas Island, offers a selection of soil amendments for gardeners. Biochar operates in a different category of soil amendment than they currently sell, which is mostly soil builders or fertilizers. The only product that is similar is worm castings, which also increase carbon, nutrient retention and biological activity. One cubic foot of worm castings retail at \$22.49, somewhat comparable to the \$17.99 price for one cubic foot

of biochar. The worm castings have an application rate of nearly one-quarter of biochar, which means that the price for biochar is three times that of worm castings for the same application. Customers would require significant assurances that the benefits would be more than three times more significant and longer than worm castings to risk investing in a new and unproven product.

Sunset Builders: Potential Retail Store

Sunset Builders, the local hardware store on Lopez Island, expressed significant interest in selling biochar in the spring of 2019. Their garden center has received a series of requests for biochar in 2018. The garden center team identified a demographic base of Lopez Island that is interested in permaculture and regenerative agriculture, a base that is already familiar with biochar. To reach a more significant demographic, the garden center team requested a series of workshops at Sunset Builders so that customers might have a more significant understanding of

biochar's benefits. In addition, they asked for an informational session on biochar for the garden center retail team, so that the sales team can better describe the product to customers.

ALTERNATIVE MARKETS: RESTORATION

Stormwater is the leading contributor to water quality pollution in Washington State.¹⁴ Low impact development (LID) systems, often called *rain gardens*, are increasingly used to manage stormwater pollution. Biochar has been illustrated to adsorb pollutants and improve the microbiota in the soil and plant root systems that can further process and break down pollutants.¹⁵ This biologically active process relies on fungal networks that deconstruct the molecular structure of toxins, transitioning the carbon elements into a food source for the mycelium. Absorptive mediums outside of a soil ecosystem can still absorb pollutants, but once saturated the medium is then removed and transitioned to another location for toxic removal. Rain gardens offer the potential for developing maturing ecosystems that can continually process and utilize excess nutrients and pollutants.



Photo: Seattle Parks via Flickr

Vicki Heater, who oversaw San Juan County's drinking water for more than 25 years, was interviewed for this study and expressed the increased interest she sees locally and nationally in bioremediation and rain garden technology for cleaning water systems. After hearing research on the increased microbial activity with biochar additions in soil, Vicki thought that biochar could become a standard part of rain garden designs, as a significant percentage of the soil material is usually compost transported to the site. She cited the potential for local biochar

¹⁴ http://pprc.org/wp-content/uploads/2014/08/Emerging-Stormwater-BMPs_Biochar-as-Filtration-Media_2014.pdf

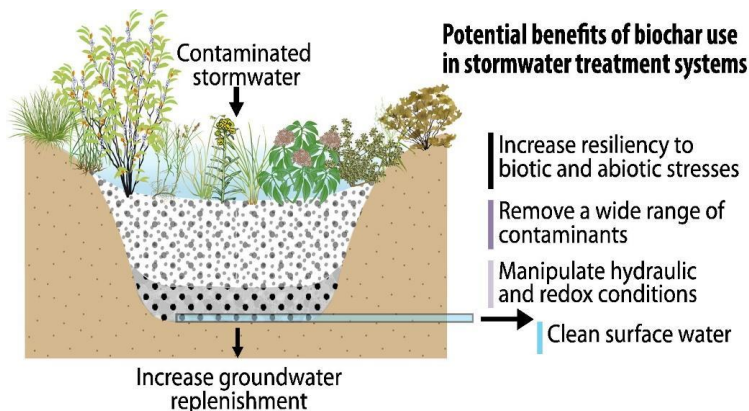
¹⁵ <https://www.sciencedirect.com/science/article/pii/S0048969718300378>

suppliers to work with rain gardens that will be installed in East Sound and Lopez Village through San Juan County Public Works, who received a \$1.7 million grant for installations to clean ground water. Biochar producers interested in working with this project can contact San Juan County Public Works directly.

Vicki also expressed the importance of getting the Natural Resource Conservation Service (NRCS) to be aware of biochar as a best management practice for absorbing excess nutrient runoff from dairies and animal farms. There is NRCS cost share funding for farmers finding ways to capture nutrient runoff through their local conservation district. Vicki thought this was particularly important for any drainage area from a barn that would move towards a ground water system such as a stream, lake, or pond.

Examples of Biochar in Remediation Work

Working on water remediation projects has become a part of Biochar Supreme's business plan. They offer a Storm Water Biochar that targets toxins from cars and industry, a Watershed and Runoff Biochar to capture nutrient runoff from animal farms, and a Heavy Metals RX as a replacement of activated carbon for absorbing excess metals. Biochar Supreme has worked with the Port of Tacoma to address excess turbidity, Zinc, Copper, Total Suspended Solids, and Chemical Oxygen Demand in the water. In addition, Biochar Supreme worked with the City of Redmond's rain gardens, situated above the city's aquifer, to decrease high concentrations of zinc, copper, and phosphorous. Olympic Biochar (OB) is used at the Port of Port Townsend in a state funded pilot project for the removal of zinc and copper from roof rain runoff. The Port of Friday Harbor has conducted trials and are currently adding biochar to their stormwater systems.



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¹⁶ <https://www.sciencedirect.com/science/article/pii/S0048969718300378>

REGIONAL MARKET ANALYSIS: PRICES OF BIOCHAR PRODUCTS

Olympic Biochar

Olympic Biochar is the major bulk supplier of biochar on the Washington peninsula. Francesco Tortorici is the founder of Olympic Biochar, which sells biochar produced as a byproduct from the Port Townsend Paper Mill. The mill produces a substantial amount of biochar per year.

Their prices are:

- Cubic yard in a tote bag is \$135 per yard
- A bulk cubic yard is \$105 per yard
- Quantity discounts are available

The two major customer demographics are co-composting operations which integrate biochar with dairy manure on the Washington peninsula and cannabis growers in Eastern Washington. Dairy farmers are using the biochar to capture nutrient runoff from manure piles and then transport the biochar to their fields to improve yields. OB is being used in stormwater runoff treatment removal of heavy metals (zinc and copper) at the Port of Port Townsend. The Port of Friday Harbor has conducted successful trials and is in the process of incorporating OB in its stormwater treatment system.

Pacific Biochar

Based in Santa Rosa, California, Pacific Biochar is producing biochar for the cheapest price found in this market survey research, as well as producing a series of biologically activated biochars fertilized with different trace minerals, rice bran, and worm castings. Pacific Biochar sells charcoal through 7 bulk soil and amendment suppliers throughout California, and 20 farm and garden retail stores in California, Oregon, and Hawaii.

Blacklite Pure: A Northern California softwood biochar from forestry residues. It is highly porous, adsorptive, and has great water holding capacity.



- Loose: \$68 per cubic yard
- Bulk Tote Bags: 1.5 cubic yards, \$132
- Bulk Tote Bags: 3 cubic yards, \$244
- Retail bags: 1.5 cubic foot, \$13 per bag

Blacklite Mix #6: This biologically activated biochar has cultures created through worm castings and rice bran. This biochar is a favorite among horticulturists using potting media or planter beds for high volume crops.

- Loose: \$133/ 1.5 cubic yards
- Bulk Tote Bags: \$245/ 1.5 cubic yards
- Retail Bags: \$17.50/ 1.5 cubic foot

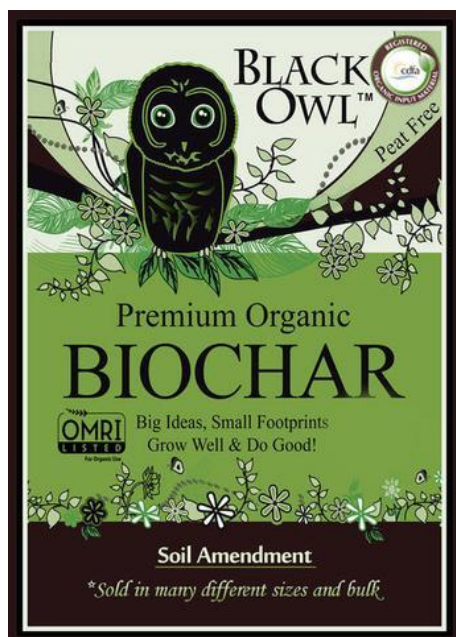


Photo: www.biocharsupreme.com

Oregon Biochar Solutions

Based in White City, Oregon, the business has partnered with a logging company to produce biochar from waste residues. More than 75% of the feedstock supplying forest owners operate in compliance with Sustainable Forestry Initiative Standards. In addition, the excess energy from the pyrolysis process generates more than 25 MW of renewable electricity for Southern Oregon. Oregon Biochar Solutions is able to offer a very dependable product produced at high temperatures, nearly 1,300 F, and a pH of 8.5, which is considered an ideal pH for maximizing biological activity increase.

- Loose: \$135.00/ cubic yard
- Bulk Tote Bags: \$249.50/ cubic yard
- Bagged Truckload of 50 Tote Bags: \$149.99/ yard

Biochar Supreme

Based in Everson, Washington, Biochar Supreme creates biochar from excess forestry residue. The business has an established relationship with a series of garden stores throughout Western Washington, and is the largest bagged supplier of biochar in the Pacific Northwest. As illustrated in the water remediation section of this paper, Biochar Supreme specializes in a series of biochar for different types of water treatment.

- Bulk Tote Bags: \$350.00
- Cubic foot bag: \$39

INTERNATIONAL BIOCHAR MARKET SUMMARY

Estimates on the global biochar market vary significantly from a series of different research and investment companies.



- The International Biochar Initiative (IBI) published an analysis for the 2014 global biochar market, interviewing 200 businesses. Those businesses cited 7,457 metric tons of biochar sold in 2014. Similar to previous findings, biochar sales had not substantially entered the industrial agriculture market.¹⁷
- Grand View Research estimates a significantly higher use of biochar globally, with demand exceeding 280 kilo tons in 2015. They project a growth rate of 12.15% each year through 2025, in which they estimate the global biochar market will reach an estimated aggregate value of \$3.14 billion dollars. Grand View Research cites research on increasing crop yield as a significant component on increasing the global market, as well as the increased popularity of organic food. Their findings on the demographics utilizing biochar varied significantly from the IBI Global Market Analysis, with agriculture serving as the largest consumer group, at 45% of the total market. A quickly growing portion of the agricultural market is the livestock sector, where it is used in animal feed to increase intestinal health and reduce disease.¹⁸

¹⁷ <https://biochar-international.org/state-of-the-biochar-industry-2014/>

¹⁸ <https://www.grandviewresearch.com/press-release/global-biochar-market>

- P & S Market Research published a report on the global biochar market through 2023 and cites the aggregated biochar market at \$4.27 million in 2015, with growth rates projected at 17.1% through 2023.¹⁹ The research group cites the growth rate from findings in the improved soil fertility, natural carbon sequestration feature of biochar, waste management potential, and increased government initiatives.
- Global Industry Analysis estimates the biochar market to reach \$15 million by 2023 at a growth rate of 17% annually. They cited improving and mounting government initiatives and stringent environmental regulations as positively affecting the growth of biochar market globally.²⁰
- Zion Market Research published a global market report on biochar from 2014-2020 and found the current world-wide market at \$260 million in 2014, and is expected to reach approximately \$585 million by 2020, with an annual growth rate of 14.5% between 2015-2020. In terms of volume, they found 100 kilo tons sold globally.²¹



Photo: Zack Dowell via Flickr

While projections of the current biochar global market range significantly, the estimated growth rates from these market research firms are consistently high, ranging from 12.5% to 17.1%. These growth rates should be considered significantly ambitious for the Pacific Northwest, as these projected growth rates anticipate biochar more fully integrating with agriculture markets than would confirm the findings from this study. Small farmers are struggling to justify the cost and are instead looking to produce it themselves. Farmers in the Skagit Valley and surrounding areas are also largely farming

on leased ground and are not looking to improve fertility levels beyond the year they grow on that land. It likely will require a change in farming economics, or available government funding for biochar production or utilization, to increase biochar adoption at a rate in accordance to these global market predictions.

¹⁹<https://www.psmarketresearch.com/press-release/global-biochar-market>

²⁰ <https://globenewswire.com/news-release/2017/11/29/1210264/0/en/USD-15-Mn-Biochar-Market-Size-Expected-to-Reach-between-2014-2023-Says-Acumen-Research-and-Consulting-Experts.html>

²¹ <https://globenewswire.com/news-release/2017/06/06/1008630/0/en/Global-Biochar-Market-Size-Expected-to-Reach-585-0-Million-by-2020.html>

EXPANDING THE MARKET FOR BIOCHAR: CONSUMER FOOD MARKETING

A potential area for increasing the use of biochar by farmers exists, if it increases the marketability of their products. As a carbon-based fertility practice, biochar is one of the cultivation techniques considered as a part of *regenerative agriculture*. Regenerative agriculture is a system of farming practices that increase soil biology, fertility, and improve watersheds while capturing carbon to reverse the effects of climate change.

Regenerative Agriculture is transitioning into the food marketplace with the Rodale Institute's new Regenerative Organic Certification. A cooperative effort between a collation of farmers, ranchers, non-profits, scientists, and brands to establish a new high bar standard for regenerative organic agriculture. The certification encompasses guidelines for soil health and land management, animal welfare, and farmer and worker financial fairness. The collaborative formed around the vision that a systemic shift to regenerative organic agricultural practices could sequester nearly a 100% of annual global carbon dioxide emissions in the soil.²²



Photo: www.lincolnu.edu

PCC Community Markets is one of the grocery store chains serving as early adopters of the certification. As the fastest growing health food chain in the greater Seattle area, PCC is using the opportunity to speak to the importance of carbon-based farming in a changing climate. Educational outreach is a foundation of the company, and they are currently looking for written and marketing materials to publicize information on carbon farming through their newsletter,

²² <https://rodaleinstitute.org/regenerativeorganic/>

the Sound Consumer. Regenerative agriculture and carbon farming have become a part of the company's strategic plan for the coming years.

Brenna Davis, the Vice President for Social and Environmental Responsibility for PCC, is significantly conscious of the carbon crisis in agriculture today, and Brenna said that the research about carbon sequestration through biochar is an example of the information they are accumulating to help inform buying decisions. PCC is looking to partner around a specialty line of coffee that is grown with biochar with Tony's coffee, a company based in Bellingham since 1971, who roasts for the PCC coffee brand. Information about biochar and the carbon influence of biochar would be a part of the coffee packaging. A percentage of each bag would also go to fund biochar kilns for the Black Earth Project, which supports biochar production throughout countries in Africa.

This partnership around biochar coffee illustrates the potential for biochar to serve as a market distinguisher in consumer purchasing decisions. David Yake, Director of Sales and Marketing at Tony's Coffee, believes the marketing appeal of biochar is linking it to climate change. "People don't know why carbon is good for the soil, but people do want to capture more carbon through the food they eat. People are wanting to find more ways to fight climate change."

CONCLUSION

There is no straight course to increasing the market for biochar in agricultural and garden markets in San Juan County and beyond. Markets can be increased through increased retail locations, further customer education and outreach, and demonstrations. To what extent that market could be expanded is unknown. While the local sales market may not exist with farmers in San Juan County, this study did find that farmers do have significant interest in producing biochar, with a score of 4.4 out of 5. Further efforts to decrease barriers for farmers to produce it, such as shared equipment and production knowledge, could result in more biochar utilized in San Juan County agriculture.

This study also learned that carbon stabilization in soil was the most important topic cited by farmers about biochar, yet the phenomenon of 'negative priming,' where biochar stabilizes the native organic carbon in the soil, is still a little-known concept. This study also found in the gardener interviews that most people who know about biochar think of the nutrient retention impact, not the carbon impact, of biochar. In accordance with Tom Mile's findings with the Northwest Biochar Working Group, the carbon argument for biochar has still not been made

clearly to the public or to many of the businesses that are selling the product.²³ Part of this gap operates when biochar is considered a commodity product. Research illustrates there are significant differences in the influence of biochar on soil carbon when made at different temperatures and from different wood types. The biochar market needs improved access to academic research to communicate the nuances of their product and more accurately predict their product's influence on the customer's soil.

Natural food companies and stores such as PCC and Tony's coffee illustrate that there is an interest on the consumer side to participate in carbon farming or regenerative agriculture for environmental reasons. The Regenerative Organic Certification illustrates the potential for carbon-based cultivation practices to become a part of the customer's purchasing decision in the supermarket, coop or farmers market.

The biochar market could expand if the NRCS Conservation Stewardship Program for biochar, Conservation Practice Enhancement E384135Z: Woody Residue Treatment, continues with the new farm bill in 2019. There is no way to predict what the financial support amount will be, but this past year it was more than \$5,000 per acre to convert forest restoration material into biochar. At this point there is no record of a farm in the United States having utilized the NRCS subsidy. But a payment of \$5,000 per acre could help subsidize forest landowners looking to restore their overstocked stands that are at risk of fire danger, and simultaneously provide low cost biochar to farmers.

Without increased understanding of biochar's role in carbon stabilization, or an understanding of why carbon in our soils is a part of supporting crop resiliency in a changing climate is, the market for biochar will likely remain stagnant and minimal. If people do not understand our soil carbon problem, they cannot understand a part of the solution. The biochar market will likely evolve as part of a network of other evolutions—specifically the marketing of regenerative agriculture and carbon-based practices to gardeners and food customers. It will also likely evolve as more gardeners and farmers see rather than hear about the benefits. As the interview with the Skagit Farmers Supply illustrated, farmers will trust their eyes and results in soils like theirs more than graphs from a lab study. One of biochar's largest challenges in accessing the market is that it addresses a system of soil health issues, creating a more complete and active soil ecosystem. The results can best be seen and tasted rather than described. Catalyzing the first series of early adopters in agriculture will play a key role in the future of biochar in San Juan County and beyond.

²³ Where Do We Go From Here: Ways Forward for the Biochar Community," Northwest Biochar Working Group, USBI Biochar Symposium 2013.





NNRG's mission is to strengthen the ecological and economic vitality of Northwest forests and communities by connecting landowners with the knowledge, skills, and markets they need to steward their forests.

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